The Airport System

It is divided into two major components, the airside and the landside. The aircraftgates at the terminal buildings form the division between the two components.

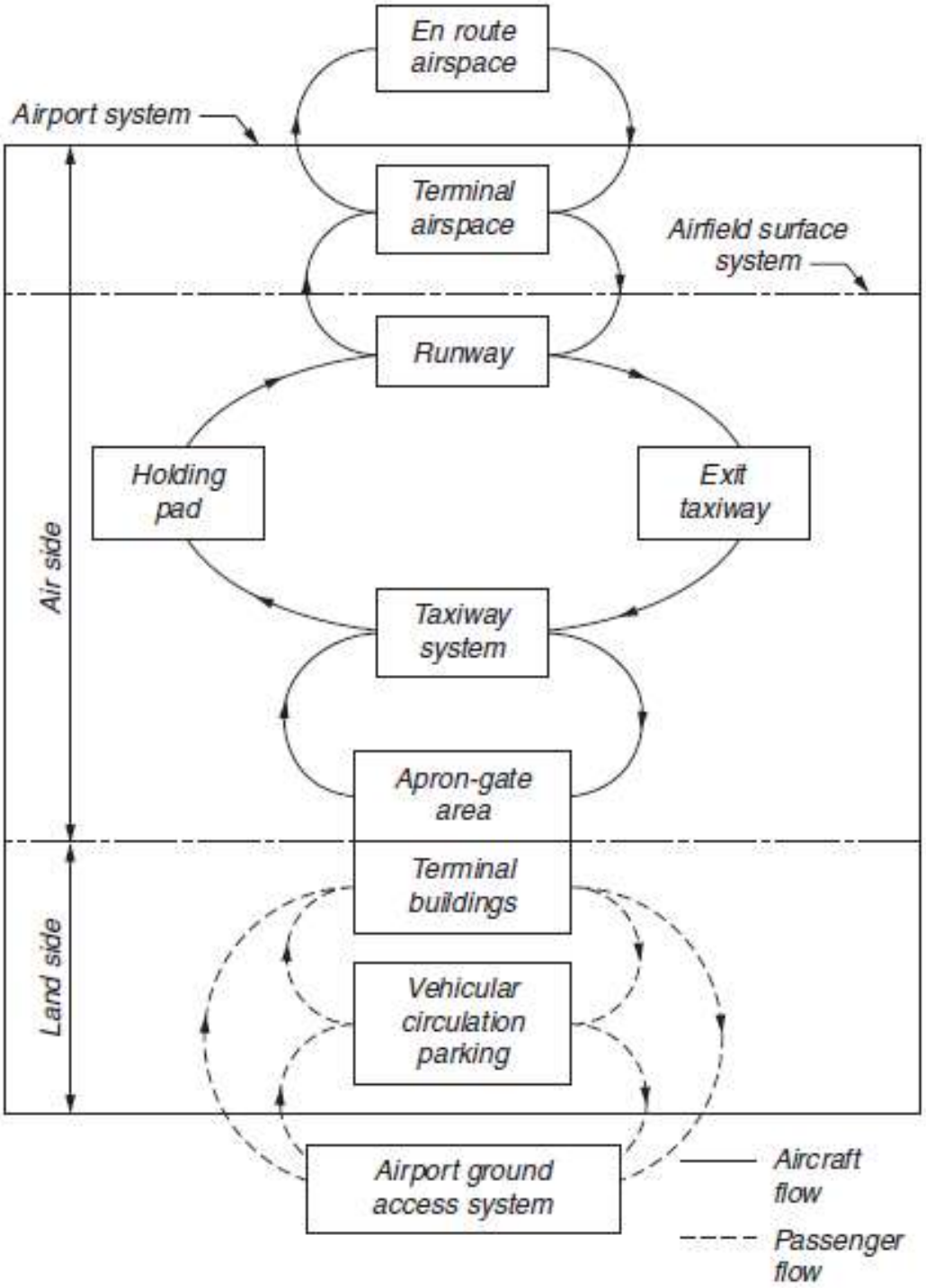

FIGURE 4-1 Components of the airport system for a large airport.

Airside Elements

→Runway(s) [and Stopway(s)]
- ↗Runway shoulders
- ↗Runway strips
- ↗Runway end safety area
- ↗Clearways

→Taxiway(s)
- ↗Taxiway shoulders
- ↗Taxiway strips

→Apron(s)
- ↗Aircraft Parking Apron
- ↗Cargo Apron
- ↗General Aviation Apron
- ↗Helicopter Apron

→Holding bay(s)

→Isolated Aircraft Parking Area

→Airfield Drainage

→Airport Periphery Road

→Aerodrome Control Tower

→Buildings for Radio Navigation Aids

→Electrical Sub-stations

→Rescue and Fire Fighting Complexes

→Aircraft Maintenance Hangars

Land side elements

→Terminals
- ↗Passenger Terminals
- ↗Cargo Terminals
- ↗General Aviation Terminal

→Administration and Maintenance Buildings

→Meteorological Services Building

→Flight Catering Building

→Fuel Farm

→Airport Hotels

→Power/Generator Houses

→Sewerage Treatment and Pump Stations

→Security Fences and Control Gates

→Car Parks

→Access Roads

The Airport System Plan

An airport system plan is a representation of the aviation facilities required to meet the immediate and future needs of a metropolitan area, region, state, or country.

The system plan presents the recommendations for the general location and characteristics of new airports and heliports and the nature of expansion for existing ones to meet forecasts of aggregate demand. It identifies the aviation role of existing and recommended new airports and facilities. It includes the timing and estimated costs of development and relates airport system planning to the policy and objectives of the relevant jurisdiction. Its overall purpose is to deter- mine the extent, type, nature, location, and timing of airport develop- ment needed to establish a viable, balanced, and integrated system of airports.

The elements in a typical airport system planning pro-cess include the following:

1. Exploration of issues that impact aviation in the study area
2. Inventory of the current system
3. Identification of air transportation needs
4. Forecast of system demand
5. Consideration of alternative airport systems
6. Definition of airport roles and policy strategies
7. Recommendation of system changes, funding strategies, and airport development
8. Preparation of an implementation plan

AIRPORT MASTER PLAN

An airport Master Plan represents a guide as to how the airport development should be provided to meet the foreseen demand while maximising and preserving the ultimate capacity of the site.

It is necessary to actually construct each of the planned facilities only when an increasing volume of traffic justifies it. Therefore the Master Plan of an airport should include the plan of the phasing of the stages of building.

Master Plan of an airport is only a guideline, and not a program of construction. Therefore it does not solve details of design.

In a financial plan, which is included in Master Plan, it is only possible to make approximate analyses of alternatives for development. The Master Plan determines the strategy of development but not a detailed plan of how to ensure financing of each of the construction stages.

A. An airport master plan is a guide for:
 development of airport facilities, for aeronautical and non-aeronautical services
 development of land uses for adjacent areas
 environmental impact assessment
 establishing of access requirements for the airport

B. Beside others an airport master plan is used to:
 provide guidance for long and short term planning
 identify potential problems and opportunities
 be a tool for financial planning
 serve as basis for negotiation between the airport management and concessionaires
 for communication with local authorities and communities

Types of actions during the airport master planning
A. Policy/co-ordinative planning:
 setting project objectives and aims
 preparing project work programs, schedules and budgets
 preparing an evaluation and decision format
 establishing co-ordination and monitoring procedures
 establishing data management and information system
B. Economic planning
 preparing market outlooks and market forecasts
 determining cost benefit of alternative schemes
 preparing assessment of catchment area impact study of alternative schemes
C. Physical planning
 system of air traffic control and airspace organization
 airfield configuration including approach zones
 terminal complex
 utility communication network and circulation
 supporting and service facilities
 ground access system
 over-all land use patterns
D. Environmental planning
 preparing of an environmental impact airport assessment

 project development of the impact area
 determining neighbouring communities' attitudes and opinions

E. Financial planning

 determining of airport development financing
 preparing financial feasibility study of alternative
 preparing preliminary financial plans for the finally approved project alternative

Steps in the planning process

1. Preparing a master planning work programme
2. Inventory and documentation of existing conditions
3. Future air traffic demand forecast
4. Determining gross facility requirements and preliminary time-phased development of same
5. Assessing existing and potential constraints
6. Agree upon relative importance or priority of various elements:
   + airport type
   + constraints
   + political and other considerations
7. Development of several conceptual or master plan alternatives for purpose of comparative analysis
8. Review and screen alternative conceptual plans. Provide all interested parties with an opportunity to test each alternative
9. Selection of the preferred alternative, development of this alternative and preparing it in final form

Plan update recommendations

A. Master plan and/or specific elements should be reviewed at least biennially and adjusted as appropriate to reflect conditions at the time of review

B. Master plan should be thoroughly evaluated and modified every five years, or more often if changes in economic, operational, environmental and financial conditions indicate an earlier need for such revision

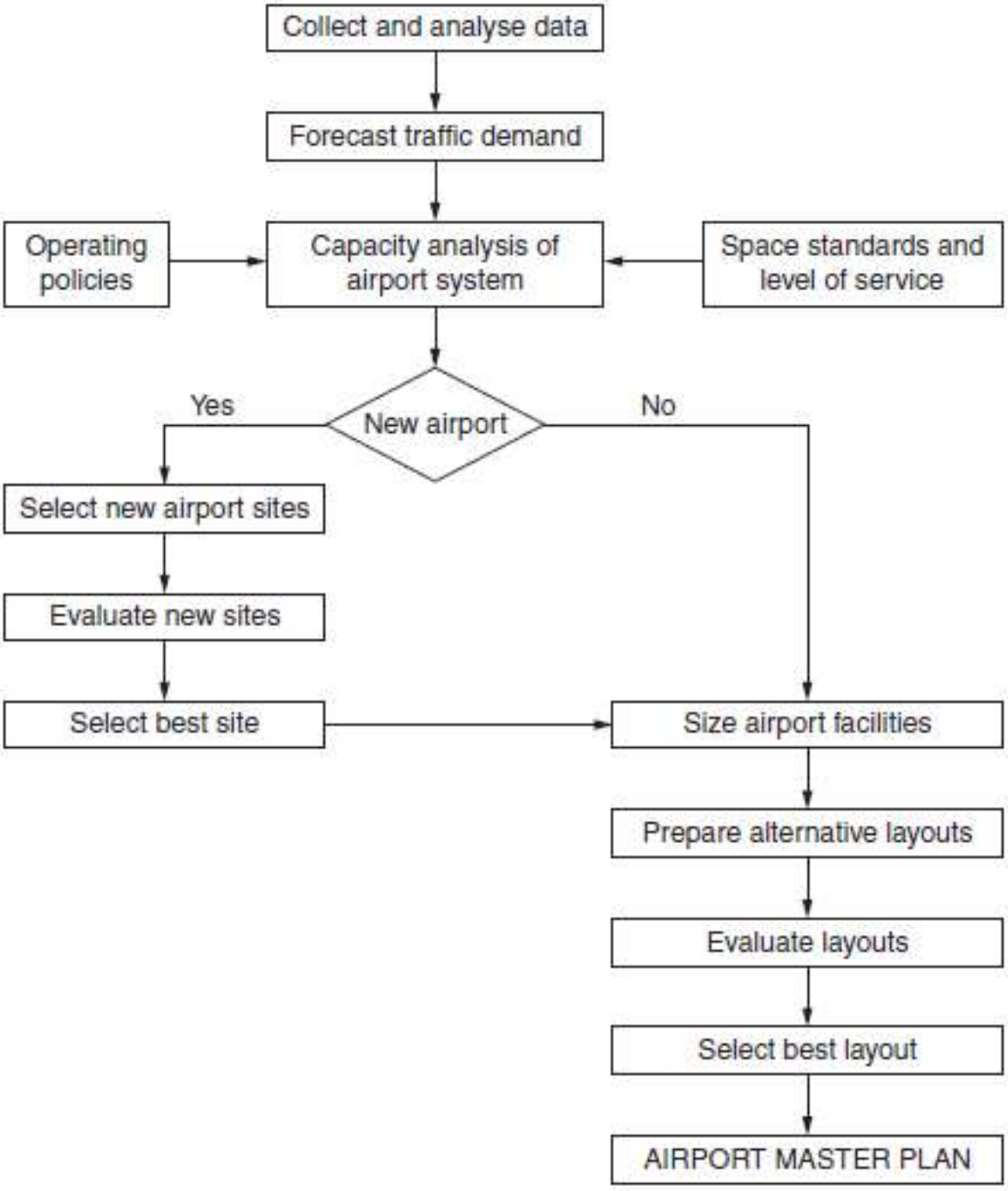

FIGURE 4-2 Flowchart for preparing an airport master plan.

A master plan report is typically organized as follows:

Master plan vision, goals, and objectives—establishes the vision and overarching goals for the master plan as well as objectives that will guide the planning process and help ensure that the goals are achieved and the vision is realized.

Inventory of existing conditions—provides an overview of the air- port's history, role in the region and nation, growth and devel- opment over time, description of its physical assets (airfield and airspace, terminal, ground access, and support facilities), and key industry trends.

Forecast of aviation demand—future levels of aircraft operations, number of passengers, and volume of cargo are forecasted for short, intermediate, and long-range time periods. Typically fore- casts are made for 5, 10, and 20 years on both annual as well daily and busiest hours of the day.

Demand/capacity analysis and facility requirements—compares the future demand with the existing capacity of each airport compo- nent and identifies the facility requirements necessary to accom- modate the demand.

Alternatives development—identifies, refines, and evaluates a range of alternatives for accommodating facility requirements. If the existing site cannot accommodate the anticipated growth, a selec- tion process to find a new site may be necessary.

Preferred development plan—identifies, describes, and defines the alternative that best achieves the master plan goals and objectives.

Implementation plan—provides a comprehensive plan for the imple- mentation of the preferred development plan, including the defini- tion of projects, construction sequence and timeline, cost estimates, and financial plan.

Environmental overview—provides an overview of the anticipated environmental impacts associated with the preferred develop- ment plan in order to understand the severity and to help expe- dite subsequent environmental processing at the project specific stage.

Airport plans package—documents that show the existing as well as planned modifications are prepared and the more notable is the airport layout plan (ALP). It comprises drawings that include the airfield's physical facilities, obstruction clearance and runway approach profiles, land-use plans, terminal area and ground access plans, and a property map. Specific guidelines for the airport layout plan in the United States are identified by FAA.

Stakeholder and public involvement—documents the coordina- tion efforts that occur among the stakeholders throughout the study.

Strategic Plans

In the field of management, *strategic planning* refers to a disciplined process for analyzing the current situation of a business activity, and identifying the vision of how that entity should position itself regarding its customers and competitors Airport managers and operators need to think strategically.

They need to examine the range of future possibilities, position their organizations to respond flexibly to the events that occur, and in fact react appropriately as the future becomes clear.

Good strategic thinking for an airport must consider the context of the airport/ airline industry. Events far beyond the airport boundaries affect the development and consequently the planning for airports.

Decisions made in faraway airline boardrooms can drastically upset airport developments. For example, US Airways' decision to consolidate its operations in Philadelphia turned Pittsburgh's airport into a "ghost town." Traffic at this former hub dropped from 19.8 million annual passengers in 2001 to only 8.0 million in 2010. Similarly, when American Airlines bought TWA and closed its hub in St. Louis, traffic there dropped from 30.6 million annual passengers to 12.4 million in just 4. years .. Likewise, . the decisions by Emirates to expand aggressively, and of Dubai to provide enormous new airport facilities, are causing shifts in traffic flows affecting major European hubs. Airports must look beyond their boundaries when they do their planning. Airport planners need to take a systems view that looks at the larger airport/ airline industry.

Forecasting

Plans for the development of the various components of the airport system depend to a large extent on the activity levels which are forecast for the future. Since the purpose of an airport is to process aircraft, passengers, freight, and ground transport vehicles in an efficient and safe manner, airport performance is judged on the basis of how well the demand placed upon the facilities within the system is handled. To adequately assess the causes of performance breakdowns in existing airport systems and to plan facilities to meet future needs, it is essential to predict the level and distribution of demand on the various components of the airport system. Without a reliable knowledge of the nature and expected variation in the loads placed upon a component, it is impossible to realistically assess the physical and operational requirements of such a component. For example, a forecast to project the mix of aircraft and the types of aviation activity at an airport site is necessary to identify the critical aircraft which dictates the elements of geometric and structural design, the type and extent of physical facilities, the navigational aid requirements, and any special or unique facility needs at the airport.

Over the years, certain techniques have evolved which enable airport planners and designers to forecast future demand. The principal items for which estimates are usually needed include

• The volume and peaking characteristics of passengers, aircraft, vehicles, and cargo

• The number and types of aircraft needed to serve the above traffic

• The number of based general aviation aircraft and the number of movements generated

• The performance and operating characteristics of ground access systems

There are four major methods:

• Time series method

• Market share method

• Econometric modeling

• Simulation modelling

Time Series Method

Time series analysis or extrapolation is based upon an examination of the historical pattern of activity and assumes that those factors which determine the variation of traffic in the past will continue to exhibit similar relationships in the future. This technique utilizes times series type data and seeks to analyze the growth and growth rates associated with a particular aviation activity. In practice, trends appear to develop in situations in which the growth rate of a variable is stable in either absolute or percentage terms, there is a gradual increase or decrease in growth rate, or there is a clear indication of market saturation trend over time

Market Share Method

Forecasting techniques which are utilized to proportion a large-scale aviation activity down to a local level are called market share, ratio, or top-down models. Inherent to the use of such a method is the demonstration that the proportion of the large-scale activity which can be assigned to the local level is a regular and predictable quantity. This method has been the dominant technique for aviation demand forecasting at the local level and its most common use is in the determination of the share of total national traffic activity which will be captured by a particular region, traffic hub, or airport. Historical data are examined to determine the ratio of local airport traffic to total national traffic and the trends are ascertained. From exogenous sources the projected levels of national activity are determined and these values are then proportioned to the local airport based upon the observed and projected trends. The ratio method is most commonly used in the development of microforecasts for regional airport system plans or for airport master plans.

These methods are particularly useful in applications in which it can be demonstrated that the market share is a regular, stable, or predictable parameter. For example, the number of annual enplaned

passengers at major air traffic hubs has been shown to be a consistent and relatively stable factor and, therefore, this method is often used to predict this parameter

Econometric Modeling

The most sophisticated and complex technique in airport demand forecasting is the use of econometric models. Trend extrapolation methods do not explicitly examine the underlying relationships between the projected activity descriptor and the many variables which affect its change. There are a wide range of economic, social, market, and operational factors which affect aviation. Therefore, to properly assess the impact of predicted changes in the other sectors of society upon aviation demand and to investigate the effect of alternative assumptions on aviation, it is often desirable to use mathematical techniques to study the correlations between dependent and independent variables. Econometric models which relate measures of aviation activity to economic and social factors are extremely valuable techniques in forecasting the future.

There are a great variety of techniques which are used in econometric modeling for airport planning. Classical trip generation and gravity models are quite common in forecasting passenger and aircraft traffic. Simple and multiple regression analysis techniques, both linear and nonlinear, are often applied to a great variety of forecasting problems to ascertain the relationships between the dependent variables and such explanatory variables as economic and population growth, market factors, travel impedance, and intermodal competition. The form of the equations used in multiple linear regression analysis is given in Eq. (5-1).

$$Yest = a0 + a1\,X1 + a2\,X2 + a3\,X3 + \cdots + anXn \quad (5\text{-}1)$$

where Yest = dependent variable or variable which is being forecast

X1, X2, X3,⋯, Xn = dependent variables or variables being used to explain the variation in the dependent variable

a0, a1, a2, a3,⋯, an = regression coefficients or constants used to calibrate the equation

Simulation

Simulation models are often used when one needs very detailed estimates of aircraft, passengers, or vehicles. These models impose precise rules that govern how passengers, aircraft, or vehicles are routed, and then aggregates the results so that planners can assess the needs of the network or a component of the airport to handle the estimated demand. Typically the outputs from the other forecasting methods are used as inputs to simulation models. Forecasts from simulation models represent snapshots of how a given amount of traffic flows across a network or through an airport, rather than a monthly or annual estimate of total traffic.

Application in Planning Studies	Forecast Variables Required
Macroforecast	
National airport system needs	Revenue passengers
State or regional airport needs	Revenue passenger-miles
Airlines	Aircraft fleet
Aircraft and equipment manufacturers	Air carrier
Investment planning	General aviation
Research and development needs	Composition
Route planning	Size
Workforce requirements	Capacity
	Enplaned passengers
	Aircraft operations
Microforecast	
Airport facilities	Aircraft operations
Airside	Air carrier
Runways	Fleet mix
Taxiways	Capacity
Apron areas	Peak hour
Navigational aids	General-aviation-based aircraft
General aviation needs	
Landside	Passenger traffic
Gates	Enplaned/deplaned
Terminal facilities	Originating/terminating
Cargo needs	Connecting/transferring
	Airlines
Curb frontage	Peaking characteristics
Parking	Cargo activity
Internal road network	Vehicle traffic
Ground access	
Regional road network	
Public transit	

Table 5-2 Typical Air Transportation Forecast Variables and Their Use in Aviation and Airport Planning

Airport site location

Airport Design Manual Part I Chapter 2/ Airport planning manual page 1-39

Many factors affect the determination of the siting, orientation and number of runways. The more important factors are:
a) weather, in particular the runway/aerodrome usability factor, as determined by wind distribution, and the occurrence of localized fogs;
b) topography of the aerodrome site and its surroundings;
c) type and amount of air traffic to be served, including air traffic control aspects;
d) aeroplane performance considerations; and
e) environmental considerations, particularly noise.
2.1.2 The primary runway, to the extent other factors permit, should be oriented in the direction of the prevailing wind. All runways should be oriented so that approach and departure areas are free of obstacles and, preferably, so that aircraft are not directed over populated areas.
2.1.3 The number of runways must be sufficient to meet air traffic demands, which consist of the number of aircraft arrivals and departures, and the mixture of aircraft types, to be accommodated in one hour during the busiest periods. The decision as to the total number of runways to be provided should also take into account the aerodrome usability factor and economic considerations.

Definitions from Annex 14 – selected

Aerodrome reference code: Annex 14

An aerodrome reference code
Consists of code number and code letter
which is selected for aerodrome planning purposes
determined in accordance with the characteristics of the aeroplane for which an aerodrome facility is intended

The code number for element 1 shall be determined from Table 1-1 selecting the code number corresponding to the highest value of the aeroplane reference field lengths of the aeroplanes for which the runway is intended.

The code letter for element 2 shall be determined from Table 1-1 by selecting the code letter which corresponds to the greatest wingspan of the aeroplanes for which the facility is intended.

Table 1-1. Aerodrome reference code
(see 1.6.2 to 1.6.4)

Code element 1	
Code number	Aeroplane reference field length
1	Less than 800 m
2	800 m up to but not including 1 200 m
3	1 200 m up to but not including 1 800 m
4	1 800 m and over
Code element 2	
Code letter	Wingspan
A	Up to but not including 15 m
B	15 m up to but not including 24 m
C	24 m up to but not including 36 m
D	36 m up to but not including 52 m
E	52 m up to but not including 65 m
F	65 m up to but not including 80 m

Factors affecting length of runway, actual length of runways,
Aerodrome Design Manual Part I Chapter 3